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#### METHOD OF OPERATION

Panel System - Final Circuit - With Time Measure Release On Permanent Signal and for Routine Testing of Subscriber's Lines.

#### DEVELOPMENT

##### 1. PURPOSE OF CIRCUIT

This circuit is for the purpose of completing connections from a manual or panel office to a subscriber's or PBX line in a ground cut-off relay panel office. It is arranged to release on "No Test" calls under control of the calling end and on permanent signals to release after a time interval. Jacks are provided whereby subscribers' lines may be tested.

##### 2. WORKING LIMITS

- 2.1 The maximum external circuit subscribers loop resistance is 750 ohms with "S" wiring and 1500 ohms with "T" wiring.
- 2.2 The minimum subscribers line insulation resistance for the above limits is 10,000 ohms.
- 2.3 The maximum external circuit loop resistance for selections is 1474 ohms with minimum trunk insulation resistance 30,000 ohms.

#### OPERATION

##### 3. PRINCIPAL FUNCTIONS

This circuit is used to establish a connection from the incoming selector multiple to a subscriber's or PBX line. Its functions are as follows:-

- 3.01 Selects proper subscriber's line by means of brush, tens and unit selections.
- 3.02 Tests subscriber's line for an idle or busy condition.
- 3.03 Advances incoming selector when selections are completed.
- 3.04 For individual line or PBX group busy - Restores elevator rod to normal and transmits "busy back" tone to calling subscriber and "busy back" ground to incoming selector circuits.
- 3.05 Prepares talking circuit when line is idle.
- 3.06 Accomplishes PBX hunting when the first line of the called PBX is busy.



- 3.07 Advances from talking position under control of the incoming selector.
- 3.08 Returns to normal after calling subscriber disconnects under control of called subscriber or interrupter.
- 3.09 Disregards busy condition on "No Test" calls.
- 3.10 Returns to normal without awaiting called subscriber's release after talking on "No Test" calls.
- 3.11 Maintains busy condition from the time that the called line has been selected (if it has been found idle) until the "tip" and "ring" leads are opened after conversation has been completed.
- 3.12 Operates trip magnet in the down drive positions.
- 3.13 Group peg count register.
- 3.14 Restores to normal on premature disconnect.
- 3.15 Restores to normal under control of incoming on tell-tale.
- 3.16 Return of sequence switch to normal, when moved out of position 1 manually.
- 3.17 Private automatic exchange (PAX) station selections.
- 3.18 Arranged for routine testing of subscribers' lines with subscriber's line test set.
- 3.19 Arranged for testing of subscribers' lines from the test desk.
- 3.20 Releases on permanent signal after an interval of time.
- 3.21 Transmits "busy back" tone to calling subscriber and returns to normal under control of incoming on tell tale.
- 3.22 Is arranged to trip ringing over tip on busy back when used with incoming arranged to connect ringing current to tip of incoming multiple.
- 3.23 Is arranged to operate a group busy register when all final in the group become busy.

#### 4. CONNECTING CIRCUITS

- 4.1 Line switch and ground cut-off relay line finder circuits.
- 4.2 Regular local, cordless and interoffice incoming selector circuits.

Standard two and three digit senders, cordless sender selector circuit and cordless senders.

Miscellaneous register circuit.



- 4.5 Miscellaneous tone and interrupter circuit.
- 4.6 Test selector circuit.
- 4.7 Subscriber's line test set.

## DESCRIPTION OF OPERATION

### 5. SEIZURE

When an incoming selector seizes the tip, ring and sleeve terminals of this circuit, ground in the incoming is connected to the sleeve terminal making this circuit busy to other hunting incoming selectors and the incoming advances to the selection beyond position. With the incoming in selection beyond position, the final (L) relay operates over the fundamental circuit in series with the stepping relay in the sender. The (L) relay operated operates the (TK) relay. The (TK) relay operated, locks to ground on the sleeve of the associated incoming selector circuit and advances the switch to position 2.

### 6. BRUSH SELECTION

With the switch in position 2, the high speed up drive magnet (HS) operates, causing the selector to move upward for brush selection. As the selector moves upward carrying the commutator brushes over the commutator segments, the A segments and brush intermittently connect ground through to the tip side of the fundamental circuit, alternately closing and opening a short circuit around the stepping relay in the associated sender circuit, thereby releasing it and permitting its reoperation. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened by the sender, releasing the (L) relay and consequently opening the circuit through the (HS) magnet, which stops the upward movement of the selector and the switch advances to position 3.

### 7. TENS SELECTION

In position 3, when the fundamental circuit is closed by the sender, the (L) relay operates advancing the switch to position 4. The (HS) magnet is again operated and the selector moves upward for tens selection. The trip magnet being operated in positions 3 to 5, the previously selected set of brushes is tripped as the selector moves upward in position 4. Also as the selector moves upward, the B commutator segments and brush intermittently connect ground to the tip side of the fundamental circuit, alternately closing and opening a short circuit around the stepping relay in the associated sender circuit, and thereby releasing and permitting the reoperation of the stepping relay until sufficient impulses have been sent back to satisfy the sender. The fundamental circuit



is then opened by the sender, releasing the (L) relay which opens the circuit through the (HS) magnet, stopping the upward movement of the selector and advancing the switch to position 5.

#### 8. UNITS SELECTION

When the fundamental circuit is again closed through in the sender, the (L) relay operates advancing the switch to position 6. The low speed (LS) magnet operates causing the selector to move upward, and the U commutator brush and segments function the same as the A commutator brush and segments as previously described. When sufficient impulses have been sent back to satisfy the sender, the fundamental circuit is opened releasing the (L) relay. The release of the (L) relay opens the circuit through the (LS) magnet stopping the selector brushes on the tip, ring and sleeve terminals of the called line and advances the switch to position 7, the A cam advancing it to position 8. When in position 6  $\frac{3}{4}$ , the (PEX) relay is connected in parallel with 40 ohm resistance (T) to the ring, but does not operate due to the high resistance to battery in the incoming circuit. As the switch advances beyond position 7  $\frac{1}{4}$ , ground is disconnected from the ring permitting the associated incoming circuit to advance.

#### 9. INDIVIDUAL LINE OR FIRST LINE OF PEX GROUP NOT BUSY

With the switch in position 7  $\frac{3}{4}$ , the (L) relay operates through its secondary winding advancing the switch to position 9. As the switch leaves position 8, the (L) relay releases and battery through resistances (B-1) and (B-2) is connected to the S terminal, operating the cut-off relay in the line circuit. The release of the (L) relay also advances the switch to position 10, the A cam advancing it to position 12, ground from the armature of the (TK) relay advancing the switch to position 13 and ground through the break contact of the (L) relay advancing the switch to position 14. As the switch passes through position 12  $\frac{1}{2}$ , ground through cam D is connected to the selector group register operating that register.

#### 10. DISCONNECTION

When the associated incoming selector advances from the talking position, ground is disconnected from the sleeve terminal releasing the (TK) relay. The (TK) relay released advances the switch to position 15. As the switch enters position 14  $\frac{1}{2}$ , the (L) relay operates through its secondary winding and holds through its primary winding over the loop to the called station. In position 15, the 500 ohm 18-AC resistance (S) is connected across the primary winding of the (L)



relay which still holds, its parallel connection being for the purpose of aiding in the release of the (L) relay when the receiver is replaced on the switchhook at the called station. When the receiver is replaced on the switchhook, the (L) relay releases and advances the switch to position 17, ground on the armature of the (TK) relay advancing the switch to position 18 where the down magnet operates returning the selector to normal. The trip magnet is operated from position 17 1/2 to 18 to prevent the possible snagging of the brushes during the return of the selector. With the selector at normal position, ground through the Y commutator segment advances the switch to position 1 releasing the down magnet. If during disconnection the receiver at the called station remains off the switchhook longer than the predetermined period, the circuit functions as follows:- When contact F of interrupter (TO) closes, the (TK) relay operates through its secondary winding advancing the switch to position 16. The (TK) relay releases when the switch leaves position 15. When contact B of interrupter (TO) closes, the (TK) relay again operates advancing the switch to position 17 where the (L) and (TK) relays release advancing the switch to position 18, and the circuit restores to normal as described above.

#### 11. NO TEST

On calls from a cordless position, when the "No Test" key is operated, the circuit functions as described in paragraphs 5 to 8 until the switch reaches position 6 3/4, when battery through a low resistance in the cordless sender selector circuit is connected to the ring side of the fundamental circuit operating the (PBX) relay. The (PBX) relay operated, releases the (TK) relay which advances the switch from position 8 to 10 without testing the called line for busy or waiting for PBX hunting, and the A cam advances it to position 12. The release of the (TK) relay connects ground to the sleeve of the incoming circuit to prevent seizure by other hunting incoming selectors. As the switch leaves position 7 the (PBX) relay releases. Since the (TK) relay is released, the (L) relay does not operate in position 8 as described in paragraph 9. In position 11, the (PBX) and (TE) relays operate in series and lock until the switch advances from position 16. In position 12, the (TK) relay operates through its primary winding, advancing the switch to position 13. Since the (L) relay is non-operated, the switch immediately advances to position 14. Disconnection takes place in the same manner as described in paragraph 10 with the following exception: The (PBX) relay operated in position 11 to 16 prevents the (L) relay from operating in position 14 1/2 as described in paragraph 10. The (L) relay being normal permits the switch to pass through position 16 regardless of whether the receiver is on or off the switchhook at the called station, and the circuit returns to normal.



## 12. BUSY INDIVIDUAL LINE

In case the called line is an individual line which is busy, the circuit functions as described in paragraphs 5 to 8 until the switch enters position 8. When the (L) relay operates in position 8, high potential battery on the sleeve terminal operates the (PBX) and (TB) relays in series and the switch advances to position 9 as previously described. The (TB) relay operated holds the (L) relay operated through winding P, and the (PBX) relay operated releases the (TK) relay. The (TK) relay released advances it to position 12. When the switch leaves position 9 1/2, the (PBX) and (TB) relays release, but the (L) relay holds through its secondary winding. In position 12, the (TK) relay operates and locks to ground in the associated incoming selector, advancing the switch to position 13, where the down magnet operated restores the selector to normal. When the selector reaches normal, ground on the Y commutator segment advances the switch to position 17. In position 12 to 13, the trip magnet is operated to prevent the possible snagging of brushes during the return of the selector. In position 17, a circuit is closed from interrupted ground over lead D from the miscellaneous tone and interrupter circuit, to operate and release the (L) relay as controlled by the interrupter. The operation of the (L) relay closes a circuit from lead B of the miscellaneous tone and interrupter circuit, resistances (B-1), (B-2) and (S) to the ring of incoming selector thereby permitting a busy back tone to the calling subscriber. When the calling subscriber or operator disconnects, the associated incoming selector advances to remove ground from the sleeve terminal, thereby releasing the (TK) relay. The release of the (TK) relay advances the switch to position 18 where ground on the Y commutator segment advances it to normal.

## 13. PBX HUNTING

If the line on whose terminals the selector brushes rest at the end of units selection is the first of a group of PBX lines and one or more of these lines is busy, when the switch reaches position 8 low potential battery on the S terminal operates the (TB) relay but the (PBX) relay fails to operate. The (TB) relay operated holds the (L) relay and as the switch enters position 9, the (LS) magnet operates causing the selector to move upward. When an idle sleeve terminal is reached, ground potential on the S lead releases the (TB) relay opening the holding circuit through the primary winding of the (L) relay, which however holds through its secondary winding to ground through the C commutator segment. The adjustment of the C commutator brush with relation to the tripped sleeve multiple brush is such that it does not break contact with the C commutator segment until slightly after the holding circuit



through the winding of the (TB) relay is opened at the time the sleeve brush breaks contact with the busy terminal and makes contact with the sleeve terminal of an idle line. The (L) relay and the (LS) magnet, therefore, remain energized and the selector continues to travel upward until the C commutator brush breaks contact with the grounded metal segment. At this time the brushes are slightly above the center of the selector terminals and a locking pawl enters the notch in the rack attached to the brush support rod. With the circuit to ground on the C commutator open, the (L) relay releases disconnecting ground from the commutator feed bar G and releasing the (LS) magnet. The selector then drops back against the locking pawl thus centering the brushes on the line terminals. During PBX hunting, ground is connected to the G commutator through cams J and I under control of the (L) relay. This arrangement is to prevent the reoperation of the (L) relay by the closing of the circuit from ground through the C commutator brush and segment as the selector drops into place. The release of the (L) relay also advances the switch to position 10, the A cam advancing it to position 12. From this point on the circuit functions as previously described in paragraphs 9 and 10. If the last line of the PBX group is reached, since the sleeve condition is the same as for an individual line, the (TB) relay releases in position 9 if the line is idle or the (PBX) relay operates in position 9 if the line is busy and circuit functions the same as described for an individual line.

#### 14. PAX DIALING

When the office in which this final circuit is located has lines terminating in private automatic exchanges, this final circuit is arranged with "X" wiring. In this case ground is connected to the ring side of the trunk until the switch advances from position 13 1/2, to hold the incoming selector in the selection beyond position. This circuit advances to position 14, talking position, as in the case of an individual line, where ground on the ring from the PAX trunk holds the incoming in the selection beyond position until all selections have been completed. This circuit remains in the talking position when PAX selections are taking place. Disconnection is the same as for an individual line.

#### 15. PREMATURE RELEASE

Should the calling subscriber replace the receiver on the switchhook or the cordless operator depress the disconnect key before the final switch advances to position 10, the incoming selector advances removing ground from the sleeve thereby releasing the (TK) relay. The (TK) relay releases advances the switch to position 10, the A cam advancing it to position 12 where the (TK) relay operates and advances the switch to



position 13. In position 13, the (TK) relay is released, providing an operating path for the (L) relay through winding S which locks, holding the switch in position 13 and operating the down magnet, restoring the selector to normal. In positions 12 to 13, the trip magnet is energized so that should this early release occur before the final has advanced beyond the brush tripping zone the trip finger will not be in the way of the returning selector brushes. When the selector reaches normal, ground on the Y commutator brush and segment advances the switch to position 17, ground on the armature of the (TK) relay advancing the switch to position 18 where ground through the Y commutator brush and segment advances it to normal.

#### 16. TELL TALE

Should the selector elevator travel to the top of the frame (tell tale position) during selection in position 4, 6 or 9 the closure to the X commutator segment will advance the switch to position 10, the A cam advancing it to position 12. The front contact of the (TK) relay advances the switch to position 13 and the back contact of the (L) relay advances it to position 14. the closure through the X commutator advances the switch to position 15. The back contact of the (L) relay advances the switch to position 17. In position 17 the circuit functions to give busy back tone and flash to the calling subscriber as covered in paragraph 12. From this point, the circuit is returned to normal as described in paragraph 12, except that the down magnet operates in 18 to restore the elevator to normal.

#### 17. ROUTINE TESTING OF SUBSCRIBERS' LINES

When used with the subscriber's line test set, jacks C and D of this circuit are connected to the corresponding jacks of the test set by patching cords. The final selector is held busy during the testing period by ground in the test set over the sleeve of jack C. The fundamental circuit is closed through the tip of jack C. The circuit functions under control of the test set as previously described on a regular call, until the (L) relay releases after completing units selection. The release of the (L) relay after units selection, does not advance the switch from position 6, as the energizing circuit for the R magnet is held open due to the insertion of the plug in jack C. In position 6, the tip, ring and sleeve brushes rest on the terminals of the line to be tested, the sleeve brush being connected through the sleeve of jack D to battery in the test set, thereby holding the selected line busy. The line is then tested through the tip and ring of jack D. All lines in the final selector multiple bank may be tested in rotation. The operation of a stepping key in the test set closes the fundamental circuit through jack C operating the (L) relay. The (L) relay operated energizes the (LS) magnet, moving the selector brushes up to the next set of line terminals. The test set opens the fundamental circuit when the selector reaches the next set of terminals, releasing the (L) relay and the (LS) magnet. To reset the selector to test another group of lines or to restore the circuit to normal, the disconnect key in the test set



should be operated or the plug removed from jack C thereby releasing the (TK) relay. The (TK) relay released, advances the switch to position 12. In position 12, the (TK) relay operates advancing the switch to position 13, where the (TK) relay being released, the circuit will return to normal as described in paragraph 15.

18. TESTING SUBSCRIBERS' LINES FROM THE TEST DESK

When provision is made to test the subscribers' line circuits from the test desk, relay (SC) is provided and "V" wiring is used. When the final selector has advanced to position 14, the talking position, the operation of a key at the test desk causes ground to be connected to the SC lead operating the (SC) relay. The operation of the (SV) relay releases the (OO) relay of the subscriber's line circuit, which in turn causes the (L) relay of the line circuit to operate and start a line finder hunting for this line. When the line is found by the line finder, a check for dial tone is obtained at the the test desk. The purpose of this test is to determine whether the subscriber's line is seized by a line finder and whether dial tone is applied to the line.

19. TEST JACK

Jack (TMB) is used to test the operation of this circuit and to make the circuit busy to other hunting selectors.

20. ALL FINALS BUSY REGISTER

When all finals in group become busy (seq. sw. advanced out of position 1) ground is removed from lead PBR to the group busy register circuit releasing a normally operated relay in that circuit, which causes the operation of a register to indicate that all the finals in the group are busy.



